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## **DISCHARGE PORT AND BREECH FOR COMPRESSED GAS GUN**

### **RELATED APPLICATIONS**

[0001] This application is a continuation of U.S. Patent Application No. 10/185,203, filed June 27, 2002, which is a continuation-in-part of U.S. Patent Application No. 09/528,482, filed March 17, 2000 which claimed priority from U.S. Provisional Patent Application Serial No. 60/125,302, filed March 19, 1999; and U.S. Provisional Patent Application Serial No. 60/138,323, filed on June 9, 1999, the disclosures of all of which are incorporated herein by this reference.

### **BACKGROUND OF THE INVENTION**

#### **Field of the Invention**

[0002] This invention generally relates to compressed gas-powered guns and more specifically to guns for firing marker projectiles such as "paint balls." The use of marking guns is well-known. Within a marking gun, there is employed a projectile which is generally in the shape of a sphere. This projectile is constructed of a thin wall which will readily break upon impact against a target. Typical material for the wall of

the projectile would be a gelatin. Within the wall of the projectile is contained a quantity of a liquid such as a colored paint. Typical paint colors would be blue, green or yellow.

### **Related Art**

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[0003] Compressed gas powered guns for the firing of projectiles have long been used. Of more recent use, such guns have been made for the firing of spherical and fragile projectiles containing a colored marking fluid, such projectiles commonly being referred to as "paint balls." Such guns are typified by other inventions of the Inventor, namely U.S. Pat. No. 5,497,758, showing a compressed gas powered gun. Problems associated with such guns include: dangerously high pressure build-up within the gun, potentially damaging the gun and endangering the user; a mechanical limitation on the cycle time of the firing mechanism limiting the firing rate of the gun; excessive shock and recoil resulting from reciprocal movement of the hammer into the firing and recocked positions.

### **SUMMARY OF THE INVENTION**

[0004] The present invention is a specially curved discharge port and port within a bolt within the breech for a compressed gas powered gun for the firing of projectiles. The invented gun has many improvements over the prior art including the use of improved gas pressure routing allowing for operation at lower pressures with no decrease in firing rate, efficiency, trajectory, or range. The structure of the present invention provides for embodiments which include the use of specific maximum angles

within the gas passage from a compressed gas storage chamber and a portion of the breech through which the gas is routed as it expands to launch a projectile from the gun.

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### **BRIEF DESCRIPTION OF THE DRAWINGS**

[0005] FIG. 1 is a side, schematic view of one embodiment of the present invention showing the invented gun in the cocked position.

[0006] FIG. 2 is a side, schematic view of another embodiment of the present invention showing the invented gun in the firing position.

[0007] FIG. 3 is a side, schematic view of a pneumatic gas cylinder assembly according to the present invention.

[0008] FIG. 4 is a side, schematic view of a section of the pressure routing system.

### **DESCRIPTION OF THE PREFERRED EMBODIMENTS**

[0009] Referring now to the drawings, an embodiment to be preferred of a compressed gas powered gun, made according to the present invention, is disclosed. The gun includes, generally, a grip 45; a body, including an upper main housing 3 and a lower main housing 1; a barrel 10; a bore 5; a bolt 9 within a breech; a hammer chamber 2; a pneumatic gas cylinder 34; a slider 33; and a trigger 24. Throughout the Description, the term "forward" indicates being towards the outer, open, free end of the barrel 10 extending from the upper main housing 3 of the gun. "Rearward" indicates the opposite direction of "forward."

[0010] As shown in FIGS. 1 and 2, a projectile feed tube 6 opens into the barrel 10, said projectile feed tube 6 for supplying the barrel 10 with projectiles 100, which are preferably spherical in form and contain a marking fluid. A conventional projectile retention lever (not shown) biased by a spring allows only one projectile 100 to enter the barrel 10 at a time.

[0011] Generally rearward and below the barrel 10, the hammer chamber 2 holds a hammer 32 which is integrally attached to the forward end of the slider 33. Slider 33 horizontally and reciprocally moveable within gas cylinder 34 from a cocked position, as shown in FIG. 1, to a firing position, as shown in FIG. 2, through the use of spring bias and compressed gas. The slider 33 is cocked by means of an electronic solenoid actuated 4-way valve 65 located in the lower main housing 1. A manifold 8 connects the 4-way valve 65 to the pneumatic gas cylinder 34. When biased to the firing position, the slider 33 forces the hammer 32 to engage a valve stem 29. A link pin 41, circular in cross-section, extends between and connects the bolt 9 to the hammer 32.

[0012] The bolt 9 is held within the gun through use of the link pin 41, attached to the hammer 32. Removal of the link pin 41 allows the bolt 9 to be removed from the gun. This may be done for routine maintenance. The link pin 41 is held in place by means of a bolt retention spring 76.

[0013] Within the pneumatic gas cylinder 34, a main compression spring 71 extends between the slider 33 and an end-cap 35 which is attached at the rearward end of the gas cylinder 34. A solid main spring guide 36 rests within the cylinder 34 between

the slider 33 and the end-cap 35, said guide 36 for receiving the coiled main compression spring 71. Slider 33 is biased forward to a firing position by the main compression spring 71 and compressed gas (not shown). The shock of the hammer 32 is dampened both as the hammer 32 moves forward into the firing position and as it returns to a recocked position. The forward motion of the hammer 32 is dampened by both the valve spring 72 and the compressed gas surrounding the valve spring 72. The rearward motion of the hammer 32 is dampened by an o-ring 84 located in gas cylinder 34, between the guide 36 and the end-cap 35.

[0014] Releasably holding the slider 33 in a cocked position is an electronic solenoid activated 4-way valve 65. The electronic solenoid 60 is actuated through a micro-switch 61 located rearward of the trigger 24. Pulling on the trigger 24 sends an electronic signal to a CPU (microprocessor) 64 located in the grip 45. This CPU 64 by means of software determines which of a number of dual in-line package (hereinafter "dip") switches 63 have been switched on or off, thereby determining the firing rate and mode selected by the user. The CPU 64 then, based on firing rate and mode, actuates the solenoid 60, causing the 4-way valve 65 to shift, causing the slider 33 to be propelled forward under the bias of spring pressure and compressed gas. The CPU 64 then deactuates the solenoid 60 causing the 4-way valve 65 to shift, and compressed gas forces the main compression spring 71 to compress thereby recocking the gun. A trigger spring 75 forces the trigger 24 back to its original position.

[0015] Compressed gas for propelling projectile 100 and for moving the slider 33 to a firing position is provided from a canister or cylinder (not shown), which may be attached directly to the gun or may be attached to the person operating the gun. The gas is fed through a high pressure (hereinafter "HP") regulator 50, and then through a passageway through a high pressure adaptor 51 to a cavity defined by lower main housing of body 1. The high pressure regulator 50 reduces the gas pressure from over 500 pounds per square inch (hereinafter "p.p.s.i.") to around (hereinafter ".about.") 250 p.p.s.i. The HP regulator comprises an HP adjustment screw 39, an HP regulator spring 73, an HP regulator piston 53, an HP regulator cup 52, and an HP regulator cup spring 74. This high pressure regulator 50 further comprises a safety feature forcibly closing the high pressure regulator cup 52 when over 800 or so p.p.s.i. is applied. This closure protects the inner workings of the gun and protects the gun's operator.

[0016] Contained within the gun are two valve means. The first valve means is for operating an LP circuit, including for propelling the slider 33. The second valve means is for operating an HP circuit, including for supplying gas to propel the projectile 100. The first valve means further comprises a low pressure (hereinafter "LP") regulator 54 for reducing pneumatic gas pressure from the .about.250 p.p.s.i. supplied to .about.85 p.p.s.i. This pressurized gas is then channeled to the gas cylinder 34 for the propulsion of the slider 33 upon actuation of the trigger 24. The LP regulator comprises an LP adjustment screw 56, an LP regulator spring 173, an LP regulator piston 153, an LP regulator cup 152, and an LP regulator cup spring 174. This low pressure regulator 54

further comprises a safety feature forcibly closing the low pressure regulator cup 152 when over 300 or so p.p.s.i. is applied. This closure protects the inner workings of the gun and protects the gun's operator.

[0017] The second valve means includes a horizontally oriented valve stem 29 which is horizontally and reciprocally moveable within the valve stem guide 30. Valve stem 29 is provided with a valve cup 28 engaged by a valve spring 72, biasing the valve cup 28 to a seated position on the valve stem guide 30 to prevent flow of compressed gas from the high pressure storage chamber 210 into the barrel 10.

[0018] It has also been found that projectile 100 velocity can be maximized through the use of specifically angled surfaces within the gas passage 4, through which the gas expands as it enters the barrel 10. The gas passage 4 is defined by the continuous conduit extending from the valve cup 28, through the valve stem guide 30 and the forward portion of the bolt 9. When the valve cup 28 is actuated to an open/firing position, the gas is allowed to expand through the conduit extending through the valve stem guide 30 and the bolt 9. Bolt 9 has an angled port 220 drilled through its forward portion. Valve stem guide 30 is the discharge port. Bolt 9 with its port 220 is in the breech of the gun. The breech is connected to the rearward port of barrel 10. The inner surfaces of the valve stem guide 30 and the bolt 9 are machined to form a conduit having a specific maximum angle through which the gas expands. It has been found by the inventor that 23 degrees  $\pm$  degrees is the optimal angle for these surfaces. Use of such angular surfaces allows the present invention to fire a projectile 100 using less than one half the p.p.s.i. of traditional

guns at the same firing rate as those guns, without jeopardizing the efficiency, trajectory or range of the projectile 100. By funneling the gas as it expands through the use of such angular surfaces, resistance is reduced, thereby allowing firing at a high firing rate to be done with lower p.s.i.

[0019] The gun further comprises an electronic system comprising a circuit board 62 containing a microprocessor (CPU) 64, and a series of dip switches 63 which can be set to control the firing rate and mode of the gun. The gun is further programmable so as to allow firing rate and mode limits to be forcibly set.

[0020] Sequential action of the gun may be seen to advantage. A projectile 100 is in place within the barrel 10. A second projectile (not shown) is held in place above the barrel 10 and within feed tube 6 by the projectile retention lever (not shown). Slider 33 is in the cocked position via the solenoid 60. It is assumed that the high pressure regulator 50 is in fluid communication with an external compressed gas source (not shown) to fill the high pressure storage chamber 210 with compressed gas.

[0021] The trigger 24 is then pulled, a microswitch 61 is activated sending a signal to the CPU 64 that the user wishes to fire the gun. The CPU 64 then determines which dip switches 63 have been preset by the user, thereby determining the firing rate and mode of the gun. Upon determining the firing rate and mode, the CPU 64 then directs the solenoid 60 to act accordingly. The firing rate and mode of the gun are detailed as follows:



**DIP Switch Settings--Modes--Rate of Fire**

(Note: the following settings are not shown in attached Figures.)

[0022] Rate of fire is dependent on the mode and switch settings of the dip switches.

Modes are:

[0023] 1. semi-auto (one single shot per trigger pull),

[0024] 2. 3 shot (3 shots if the trigger is pulled and not released, with single shot capabilities),

[0025] 3. 6 shot burst (6 shots if the trigger is pulled and not released, with single shot or any amount between capabilities),

[0026] 4. Full auto (as long as the trigger is pulled it will cycle).

[0027] Mode selection is done via switches #1 and #2. Mode settings using the switches are as follows:

#1	#2	
off	off	Semi automatic mode
on	off	3 shot mode
off	on	6 shot burst mode
on	on	Full auto mode

[0028] Rate of fire and timing is as follows:

[0029] Dip switch #3 and #4 (registers Solenoid on; times in milliseconds)

#3	#4	
off	off	06 ms
on	off	08 ms
off	on	10 ms
on	on	12 ms

[0030] Dip switch #5, #6, and #7 (registers Solenoid off (delay before re-cycle); times in milliseconds)

#5	#6	#7	
off	Off	off	70 ms
on	Off	off	80 ms
off	On	off	90 ms
on	On	off	100 ms
off	Off	on	110 ms

on	Off	on	120 ms
off	On	on	130 ms
on	On	on	140 ms

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[0031] Dip switch #8: display cycle rate, mode and shot count.

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On	display yes
Off	display no

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[0032] As the solenoid 60 is deactuated, the gun is cocked. As the solenoid 60 is actuated, compressed gas and the main compression spring 71 move the hammer 32 and slider 33 to the firing position, by moving the slider 33 forward with hammer 32 slidably engaging the valve stem 29. The hammer 32 engages valve stem 29, thereby unseating the valve cup 28, causing the release of compressed gas into the gas passage 4, thereby propelling the projectile 100 through the barrel 10.

[0033] The slider 33 has moved forward into the firing position forcing the hammer 32 to engage the tip of valve stem 29. Simultaneously, valve stem 29 is forced inwardly against the bias of valve spring 72 to unseat the valve cup 28 from its seat, thus allowing the compressed gas to enter the barrel 10. Gas entering the barrel 10 progresses

through the conduit formed by angular surfaces of the valve stem guide 30 and the port 220 in the forward portion of the bolt 9, forcing projectile 100, which has a diameter approximating that of the bore 5 of the barrel 10, out of the barrel 10 at a velocity dependent upon the gas pressure within the barrel 10 which is controlled by high pressure regulator 50. The solenoid 60 is then deactuated to force the slider 33 and hence hammer 32 back to the recocked position. Valve stem 29 is again biased into its seated position by valve spring 72 to prevent further flow of compressed gas into the barrel 10. Upon deactuation of solenoid 60, the slider 33 and hence the link pin 41 and bolt 9 are forced back to the recocked position. As the bolt 9 moves to the recocked position, the projectile retention lever (not shown) allows a new projectile 100 to enter barrel 10 and again holds a next projectile (not shown) in place under bias of a spring.

[0034] Having thus described in detail a preferred embodiment of the present invention, it is to be appreciated and will be apparent to those skilled in the art that many physical changes could be made in the apparatus without altering the inventive concepts and principles embodied therein. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the forgoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore to be embraced therein.